center spot (the zero layer curve at $\theta=0°$) gives $a_2$. $i_2$ is determined from the curve. To find $i_1$, we observe that the total displacement on one side of the center of the film is the sum of the displacements due to rotations $A$ and $B$ and on the other side is their difference. From the value of $i_2$ just found we determine the displacement at $\theta=45°$ due to rotation $B$. When this value is subtracted from the larger of the two displacements at $\theta=45°$, we have the displacement due to rotation $A$ and $i_1$ is obtained from the curve.

The zero layer curve, $C$, shown in the diagram is produced when the top of the zone line is rotated away and to the left as seen from the source of x-rays.

In the procedure discussed by Kratky and Krebs, the necessary measurements on the photographic film are the vertical distance between the maximum and minimum points of the zero layer curve and the determination of the $2\theta$ or $\xi$ values at which these points occur. When a finite range of oscillation is used, the x-ray diffraction spots do not fall on a smooth curve but scatter on either side of the curve. The location of the maximum and minimum points of the curve is subject to considerable error. This difficulty is enhanced by the fact that the slope of the curve is nearly zero for considerable distance either side of the maximum or minimum point. In the method discussed in this paper only displacements of the zero layer curve at definite values of $\xi$ are measured. Thus it seems that this method should introduce less uncertainty into the calculation for the final adjustment of the crystal than that of Kratky and Krebs.

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# A Simple Quartz Fiber Electrometer

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THE quartz fiber electrometer to be described in the following note has proved to be an extremely useful instrument in the study of weak radioactive sources. Because of its low capacity, simplicity of construction and general ruggedness, it has found many applications.

In some respects, the instrument is similar to the gold leaf electroscope, but much reduced in size and using gold-coated quartz fiber in place of a gold leaf. An important feature is that the restoring force is not greatly influenced by gravity. The fiber is supported as a cantilever, providing its own restoring action. A more or less accidental combination of effects of changing repulsion and restoring forces, and changing capacity tend to make the scale quite linear. The scale as used here is linear to about 1 percent for 0.6 to 0.7 of the range, and, by offsetting the zero point, one can obtain linearity over the entire range. If used over the same range of scale, the instrument is reliable to better than $\frac{1}{2}$ percent.

The essential features of construction are shown in Fig. 1. In an aluminum stand is mounted an amber post 1 mm in diameter and 3 mm long, in the end of which is drilled a hole to carry the fiber support. This element is merely a piece of wire bent to form an $L$, on one leg of which is fastened with shellac a 3 micron quartz fiber 6 mm long. To facilitate reading the position, a cross fiber is placed on the end of the fiber and is then viewed from below with a 25 power

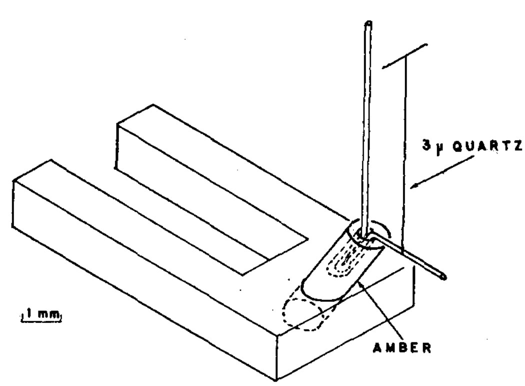

FIG. 1.

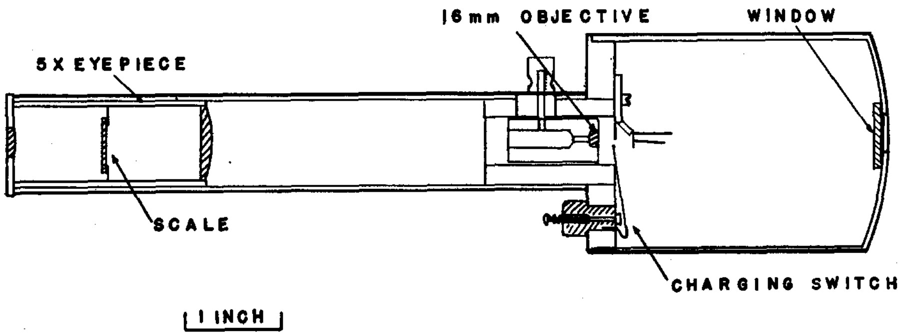


FIG. 2.

microscope. After assembly, the unit is rendered conducting by the evaporation of an opaque layer of gold. The capacity of such a unit is about 0.2 cm, and its sensitivity about 1 div./volt, making the ion sensitivity about 1.5 million ions per division. By making the fiber lighter, one can obtain sensitivities as high as 700,000 ions per division.

A very convenient combination of ionization chamber and electrometer which has been used in this laboratory is illustrated in Fig. 2. In this form, with the whole in one unit, the instrument can be quite easily carried about, read while held in the hand, and charged with a comb or fountain pen. Instruments of this type have been constructed with sensitivities from 1 to 5 div./min./mC at 1 meter, and with backgrounds from 2 to 10 div./hr. or from five to ten times the normal cosmic-ray ionization. It has been found that shielding from the alpha-particle contamination of the aluminum by means of a layer of lampblack and lacquer will cut down the background about 25 percent.

Amber is used for the insulator because of its great independence of humidity. Tests in a vacuum chamber have shown that leakage is less than 1 percent of the background, and the same unit in a 1 cc ionizing volume stays charged for months. One disadvantage of amber is the so-called "soaking" effect which makes the background high for some time after the first charging of a day, but, by making the insulator small, it is possible to cut this time to ten or fifteen minutes. On subsequent runs, only a minute or two is necessary for the system to come to equilibrium.

With the less sensitive fibers, not so much influenced by temperature effects, it is quite feasible to place radioactive sources inside the can and thus eliminate losses in windows.

Because of the small size of the sensitive element, it can be placed in a volume as small as 0.5 cc, and used in thimble chamber measurements. Its low capacity has made it adaptable for an electrostatic voltmeter, reading as high as 750 v.